Extreme Events and Impacts on Older Adults: Changes in the Equation

Climate Change and the Health and Well-being of Older Americans: Setting a Research Agenda

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Overview

- What We Know
- The Risk Equation
- Changing Variables
- Framing the Problem
- Guiding Adaptation

Extreme Events and Elders' Health

WHAT WE KNOW

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We Know This . . .

CLIMATE CHANGE AND OLDER AMERICANS:

THE STATE OF THE SCIENCE

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Summary

- Older people are often listed as one of the groups most vulnerable to climate change in general and extreme events in particular
- There is a moderate body of evidence exploring the health impacts of extreme events and disasters on elders
- Of climate sensitive exposures, heat has been best studied, though there is substantial literature on disaster health impacts generally in the US and abroad
- Mortality is better studied than morbidity, though elders' mental health has been closely evaluated
- For exposures and outcomes that have not been closely studied and for which age-stratified risks are unavailable, composite estimates are commonly substituted and generalizations offered

Heat

- Morbidity and mortality associated with heat increase with increasing age, infirmity, and certain medications
- People 65+ have a 12-23 x risk of heat stroke (roughly 25% mortality) (Applegate et al., 1981; Caruso and Posey, 1985)
- A recent summary (Daniel et al., 2011) supports these findings for mortality and found substantial heterogenieity in morbidity

Applegate, W. B.; Runyan, J. W.; Brasfield, L.; Williams, M. L.; Konigsberg, C.; Fouche, C. (1981). Analysis of the 1980 heat wave in Memphis. *J Am Geriatr Soc*, 29: 337-342.

Caruso, C.; Posey, V. (1985). Heat waves threaten the old. *Geriatr Nurs*, 6: 209-212.

Daniel, O. A.; Bertil, F.; Roclove, J. (2011). Heat wave morbidity and mortality in the elderly population: A review of recent studies. *Maturitas*, doi:10.1016/j.maturitas.2011.03.008.

Studies of the relationship between heat waves/high temperature and morbidity published between 2008 and 2010.

Morbidity studies where the elderly were analysed as a sub population				
Reference	Region and population	Exposure and threshold	Outcome variable	% change in outcome variable per 1 °C increase in temperature above threshold
Bhaskaran [11]	15 conurbations in England and Wales 2003–2006	Daily max. and min. temp.	Hospital admissions for myocardial Infarction	No increase in risk regarding heat
Knowlton [13]	California heat wave 2006	Heat wave 15th July–1st August. Reference period 8–14 July and 12–22 August	Hospital admissions and emergency department visits	65+:increased rate ratio for heat related illnesses: emergency department: RR = 10.87 (8.39–14.31) hospitalisations:RR = 14.23 (9.56–22.08)
Lin [12]	New York City residents. June–August 1991–2004	Daily mean and mean app. temperature thresholds: 28.9–29.4 °C (T) 31.7–35.6 °C (AT)	Hospital admissions for respiratory or cardiovascular disease	75+: hospital admissions increase by 4.7% for respiratory causes and by 3.5% for cardiovascular causes above threshold
Hansen [14]	Adelaide, Australia 1st January 1995–31st December 2006	Heat waves versus non-heat wave periods	Hospital admissions for renal disease	Increased risk among elderly during heat waves, higher for females than males IRR: 65+: all: 1.086 males: 1.051 females: 1.085 85+: All: 1.196 males: 1.046, females: 1.218
Hansen [15]	Adelaide, Australia 1st July 1993–31st December 2006	Heat waves versus non-heat wave periods	Hospital admissions for mental and behavioural disorders	Increased risk for 75+ by 17.1% (males) and 19.0% (females) for hospital admissions for mental and behavioural disorders during heat waves compared with non-heat wave periods
Michelozzi [10]	12 European cities 1990–2001	Maximum app. temperature city specific thresholds ranging from 14.7 °C to 29.5 °C	Daily hospital admissions for cardiovascular, cerebrovascular, and respiratory causes	75 +: respiratory admissions increased by 4.5% (1.9–7.3) and 3.1% (0.8–5.5) Mediterranean and North-Continental cities respectively (pooled estimates) cardiovascular and cerebrovascular causes did not show statistically significant differences

Additional Findings: Heat

- There was no consistent effect modification by SES observed for heat related mortality.
- Use of antidepressant and antipsychotic medications is consitently related with higher mortality
- Mortality generally spiked the day of or one day after an extreme heat day, and increased with heat wave duration
- No confounding by air pollution was found

Daniel, O. A.; Bertil, F.; Roclove, J. (2011). Heat wave morbidity and mortality in the elderly population: A review of recent studies. *Maturitas*, doi:10.1016/j.maturitas.2011.03.008.

Overall Conclusions: Heat

The elderly appear to be at higher risk than younger populations during hot days and heat waves. However, there is a need to further investigate, quantify and explain the excess deaths related to elevated temperature in an increasingly elderly population. Future research should focus on identifying predictive factors of heat related illnesses and to more extensively describe non-fatal effects of heat, which are currently under-represented in the literature. Studies examining modifications to urban environments and housing, and their effect on mortality and morbidity in elderly populations are also needed.

Daniel, O. A.; Bertil, F.; Roclove, J. (2011). Heat wave morbidity and mortality in the elderly population: A review of recent studies. *Maturitas*, doi:10.1016/j.maturitas.2011.03.008.

Storms

- There is less evidence regarding the health impacts of extreme precipitation and hydrometeorological disasters on elders
- 60% of flood-related deaths from Katrina were among people 65 years or older (Jonkman et al., 2009)
- Some health effects are related to displacement and difficulty transferring institutionalized elderly patients adequately
- Elderly patients with Mental health conditions experience exacerbations at higher rates after floods (Hayes et al., 2009)
- Several studies have found durable mental health impairments after flood exposure of 18-24 months, while others have found the elderly to be more resilient than younger populations

Jonkman, S.; Maaskant, B.; Boyd, E.; Levitan, M. (2009). Loss of life caused by the flooding of New Orleans after Hurricane Katrina: Analysis of the relationship between flood characteristics and mortality. *Risk Anal*, 29: 676-698.

Hayes, J.; Mason, J.; Brown, F.; Mather, R. (2009). Floods in 2007 and older adult services: Lessons learnt. *Psychiatric Bulletin*, 33: 332.

Other Potential Associations

- Extreme precipitation events are associated with waterborne disease outbreaks (Curriero et al, 2001) and elderly patients have higher case-fatality rates for diarrheal disease

Drivers and Points of Leverage

THE RISK EQUATION

Conceptualizing Risk

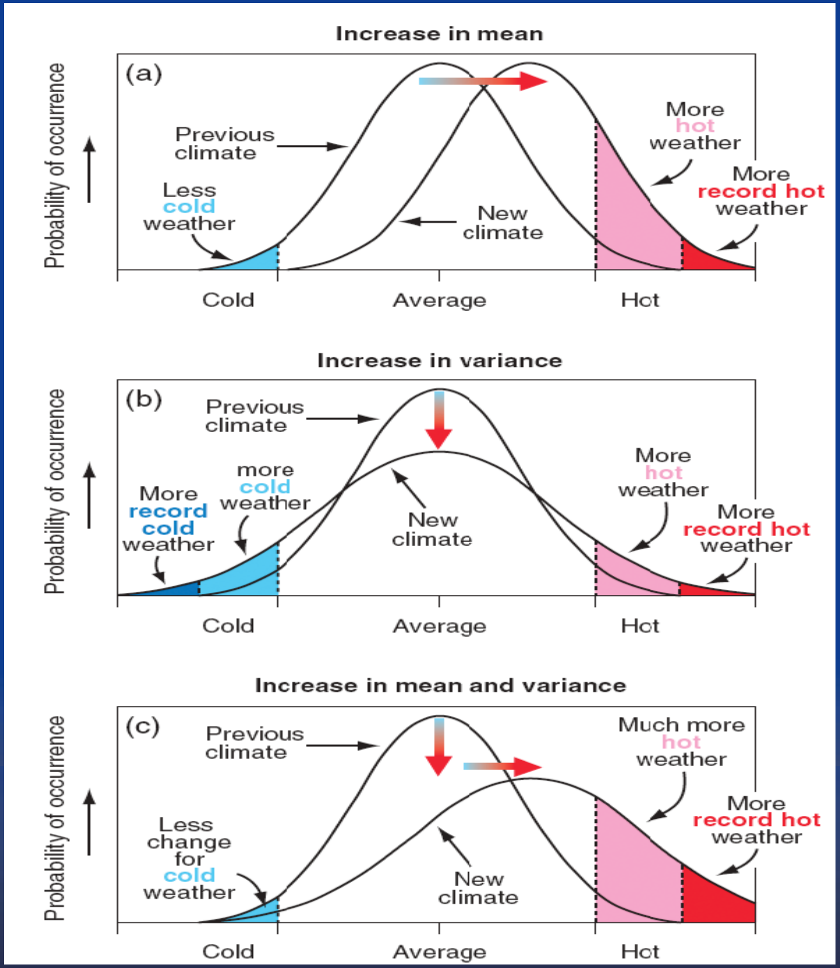
- Climate Change (Schneider et al., 2007):
  - Risk = Probability x Consequence
- Disaster Medicine (Keim, 2008):
  - Risk = Hazard Probability x Vulnerability;
  - Vulnerability = (Exposure x Susceptibility)/Resilience
- Other slight modifications in various disciplines

Schneider SH, Semenov S, Patwardhan A et al (2007) Assessing key vulnerabilities and the risk from climate change. In: Parry M, Canziani O, Palutikof J et al (eds) *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

Keim, M. (2008). "Building human resilience: The role of public health preparedness and response as an adaptation to climate change." *American Journal of Preventive Medicine* 35(5): 508-516.

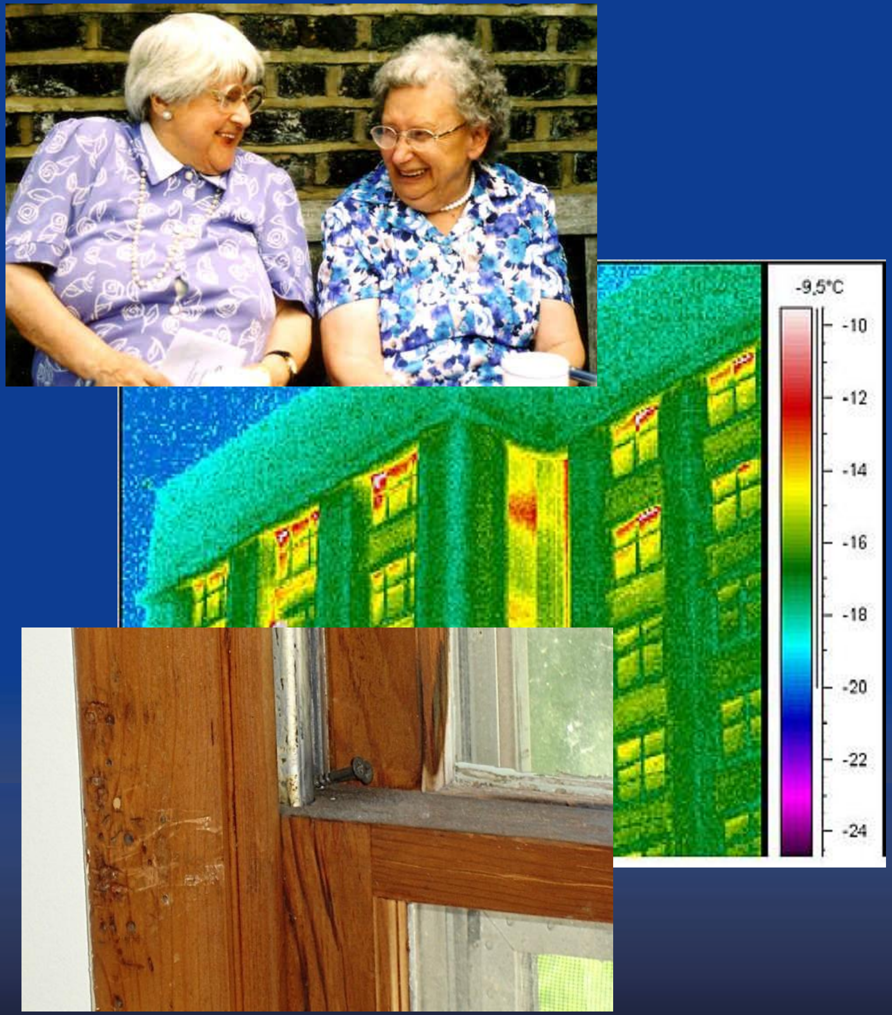
Hazard Frequency

- Hazard: Situation with potential for harm to life, health, property, or environment
- Hazard probability distribution functions (PDFs) are shifting
  - More frequent
  - Higher intensity
  - Longer duration
  - Shifting locations
- Hazards for older adults are not just physical



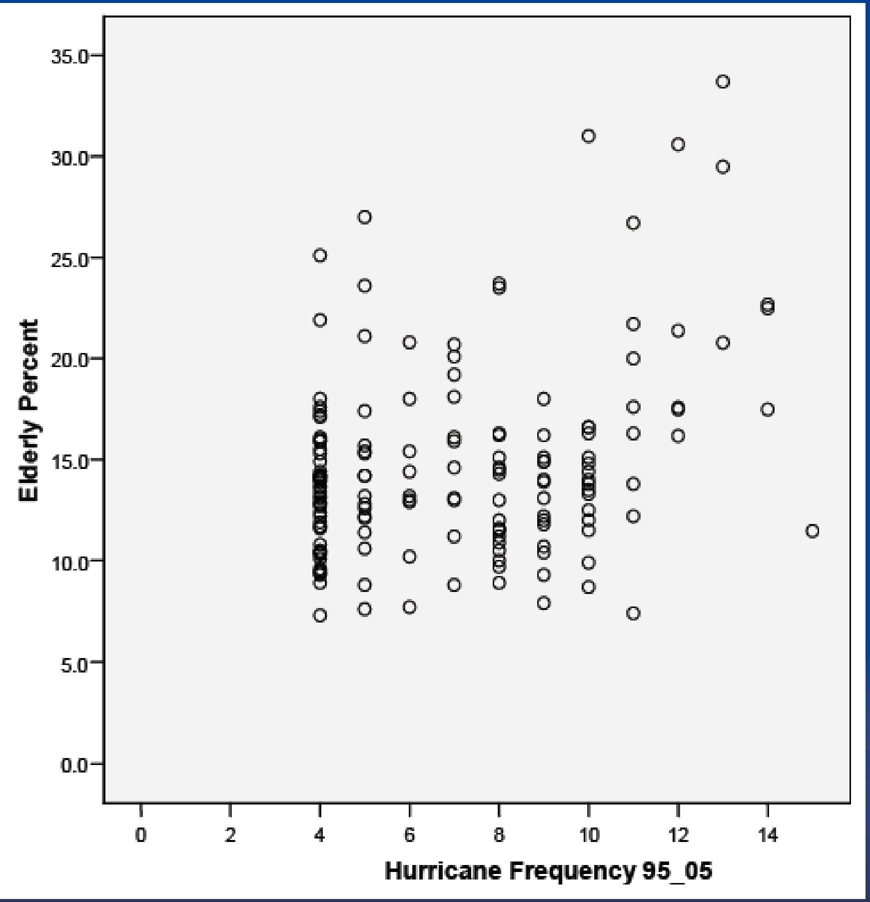
Vulnerability: Exposure

- Actual exposure to the hazard when it occurs
- For example, exposure to significantly elevated temperatures during a heat wave
- Affected substantially by demographics, regional population shifts, housing stock, local social capital



Exposure Continued

- The elderly population is not uniformly distributed
- As of early in the 21st century, half of the elderly population lived in 5% of the counties
- In states prone to hurricanes, elderly populations and other social vulnerability factors cluster (Zimmerman et al., 2007)



Zimmerman, R.; Restrepo, C. E.; Nagorsky, B.; Culpen, A. M. (2007). Vulnerability of the elderly during natural hazard events. In Proceedings of the Hazards and Disasters Researchers Meeting (pp. 38-40). Boulder, CO: Natural Hazards Center.

Vulnerability: Susceptibility

- Effect of exposure's impact
- Elderly more susceptible to environmental hazards as a result of several physiologic and socioeconomic factors

Heat Susceptibility Factors

Protective

- Intact thermoregulatory mechanisms
  - Sweating
  - Thirst
  - Renal function
  - Cardiovascular function
- Intact recognition of adverse exposure
- Intact behavioral response
- Resources
- Agency
- Social capital

Harmful

- Impaired thermoregulation
  - Impaired sweating (anticholinergics)
  - Impaired thirst impulse
  - Kidney and CV disease
  - Obesity
- Impaired cognition
- Impaired behavioral response
- Inadequate access to preventive resources
- Social isolation
- Lack of agency

Other Susceptibility Factors

- Mobility and frailty
- Functional limitations
- Multiple co-morbid conditions / chronic diseases
  - Respiratory disease
  - Cardiovascular disease
  - Overweight and obesity
  - Neurological disease
- Social isolation
- Fixed income
- Poverty
- Lack of geographic mobility
- Social capital
- Lack of caretaker planning

Elderly and Disaster Risk

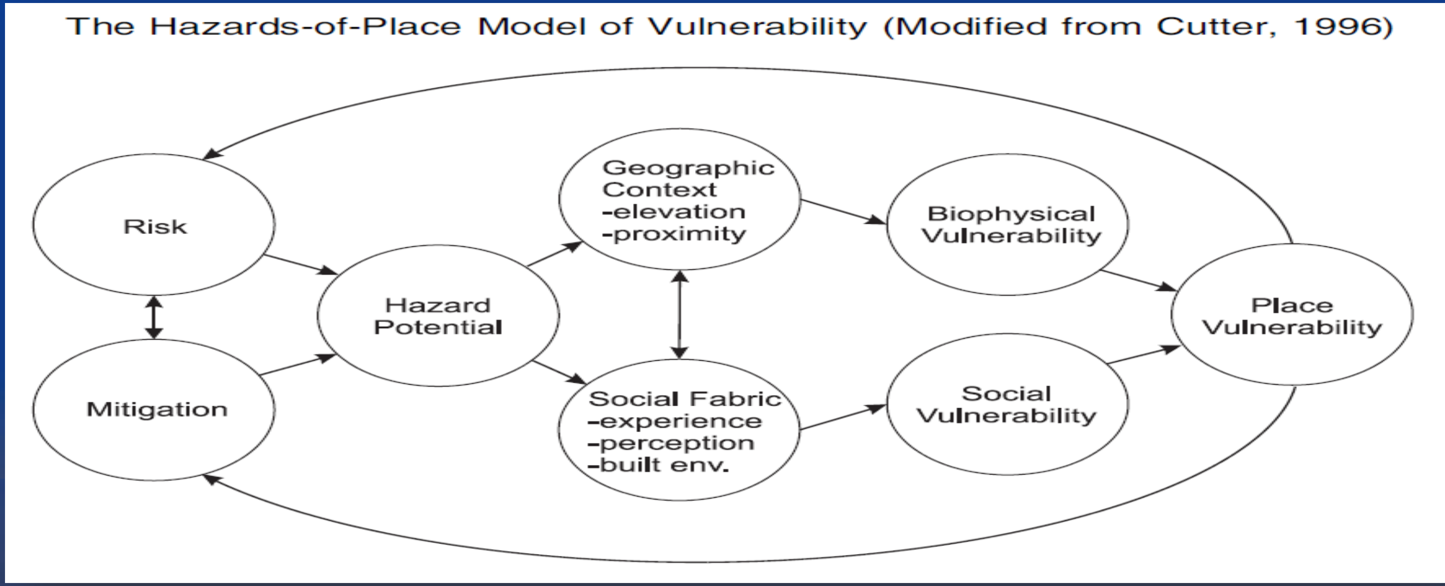
- Evacuation is key, and for this awareness, trust, and facilitation are all pivotal
- Those who do not trust authorities or believe they are at risk will typically not evacuate (Rosenkoetter et al., 2007)
- Lack of anticipation and planning is significant
- 31.6 % older adults with a disability and 16.6 % requiring the use of special equipment are community dwelling (McGuire et al., 2007)
- Older adults who need special eqpt were likely to be female, unmarried and white, and to rate health as fair/poor.

Rosenkoetter, M. M., E. K. Covan, et al. (2007). "Perceptions of older adults regarding evacuation in the event of a natural disaster." *Public Health Nursing* **24(2): 160-168.**

McGuire, L. C., E. S. Ford, et al. (2007). "Natural disasters and older US adults with disabilities: implications for evacuation." *Disasters* 31(1): 49-56.

Vulnerability Analysis

- We do not yet have a quantitative vulnerability analysis linking climate-sensitive exposures and older Americans
- Such an analysis needs to be dynamic

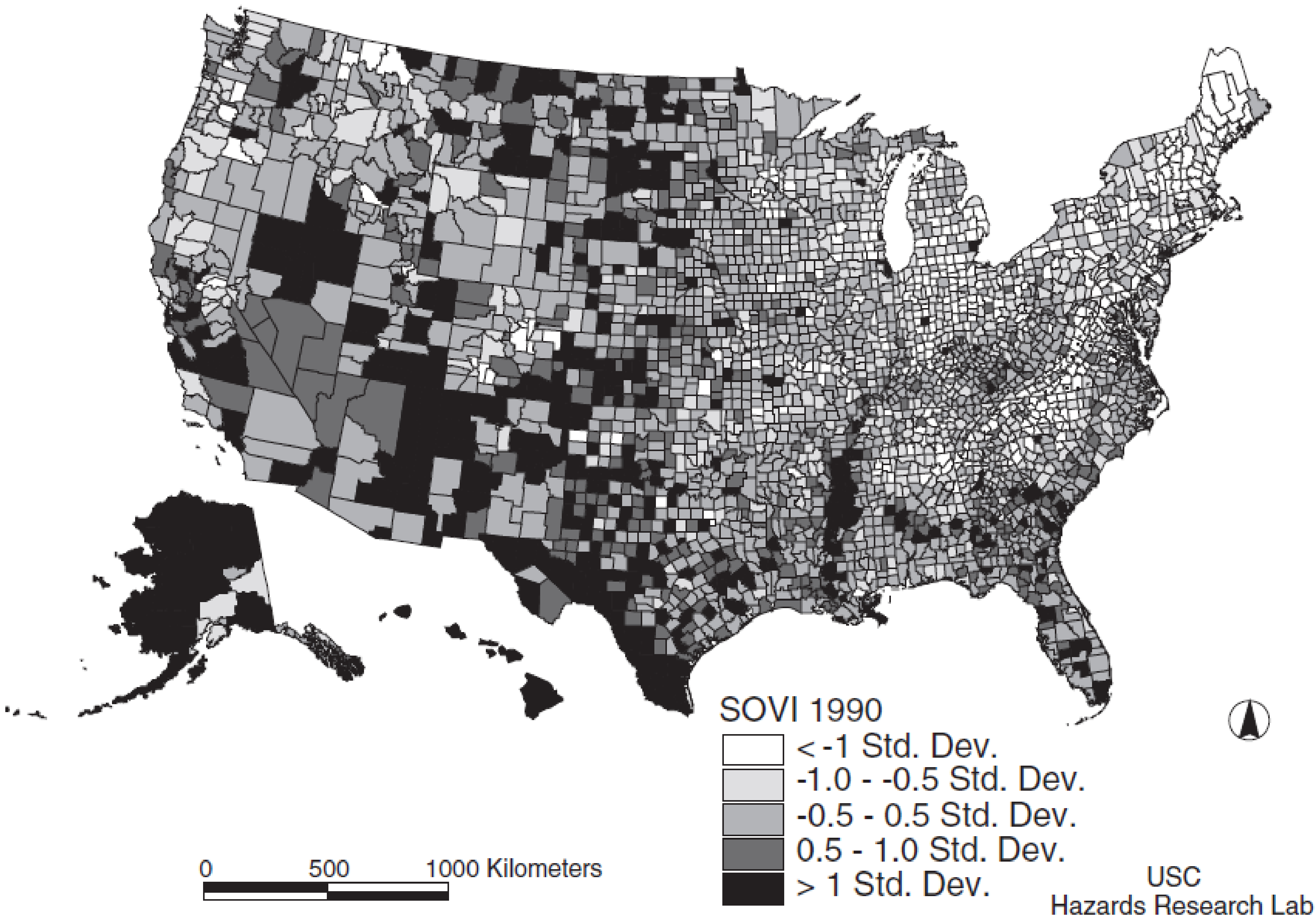


Cutter, S. L.; Boruff, B. J.; Shirley, W. L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly* 84: 242-261.

Dimensions of Social Vulnerability

Factor	Name	Percent Variation Explained	Dominant Variable	Correlation
1	Personal wealth	12.4	Per capita income	+0.87
2	Age	11.9	Median age	−0.90
3	Density of the built environment	11.2	No. commercial establishments/mi^2	+0.98
4	Single-sector economic dependence	8.6	% employed in extractive industries	+0.80
5	Housing stock and tenancy	7.0	% housing units that are mobile homes	−0.75
6	Race—African American	6.9	% African American	+0.80
7	Ethnicity—Hispanic	4.2	% Hispanic	+0.89
8	Ethnicity—Native American	4.1	% Native American	+0.75
9	Race—Asian	3.9	% Asian	+0.71
10	Occupation	3.2	% employed in service occupations	+0.76
11	Infrastructure dependence	2.9	% employed in transportation, communication, and public utilities	+0.77

Comparative Vulnerability of U.S. Counties Based on the Social Vulnerability Index (SoVI)



How Climate Change May Shift Key Variables

CHANGES IN THE EQUATION

Shifts & Needs

Projected Shift

- Changing geographic hazard distribution
- Regional hazard amplification (e.g. sea level rise, migration, loss of social supports)
- Feedbacks of increased vulnerability on exposure likelihood

Needed Information

- Overlapping vulnerability maps
- Dynamic projections of potential cascading impacts from amplified risks
- Methods for linking serial losses (economic, social, etc.) with health outcomes

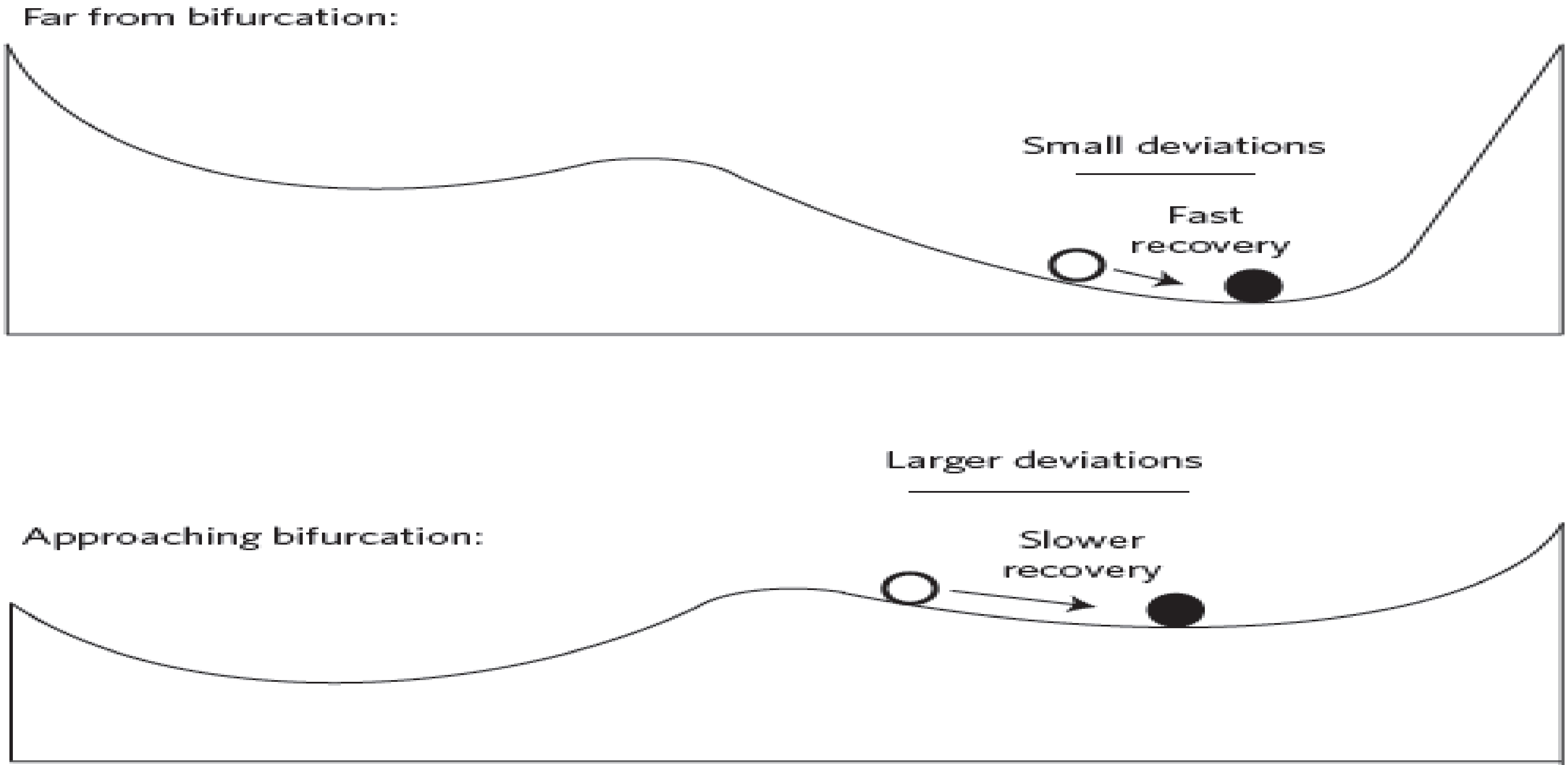
Shifts & Needs Continued

Projected Shift

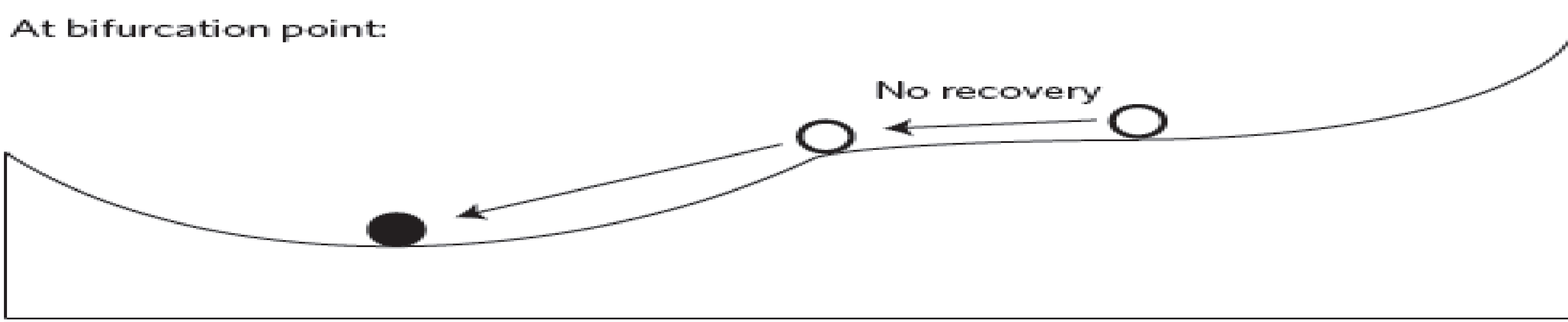
- Increasingly prevalent chronic disease and decreased mobility
- Shifting perceptions of authority and risk related to disasters
- Tipping elements and tipping points in the climate-vulnerability nexus

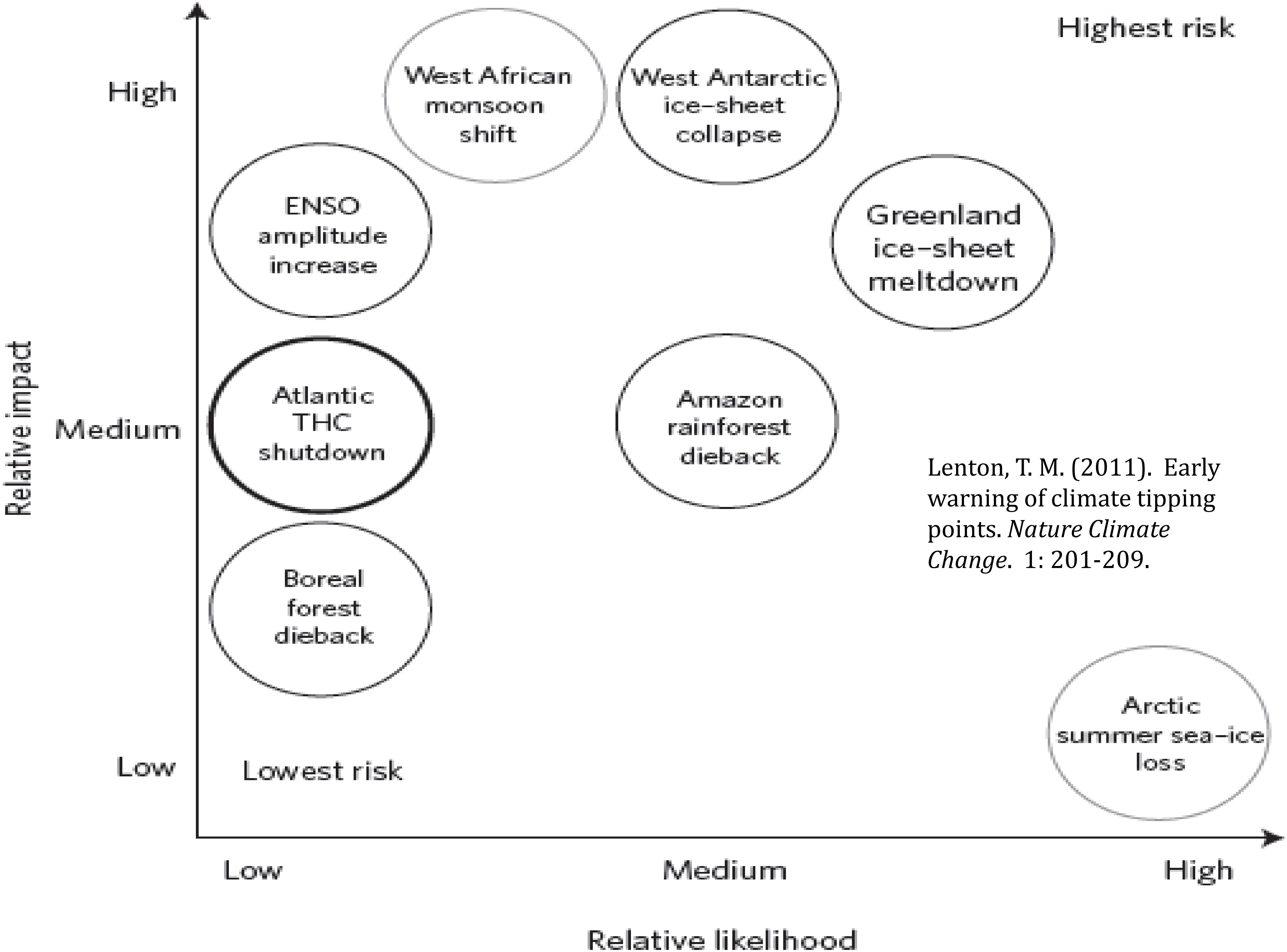
Needed Information

- Location specific projected rates to facilitate evacuation planning
- Factors affecting perceptions and likelihood of planning and evacuation
- Regionally specific scenarios that could lead to disastrous outcomes



Lenton, T. M. (2011). Early warning of climate tipping points. *Nature Climate Change*. 1: 201-209.



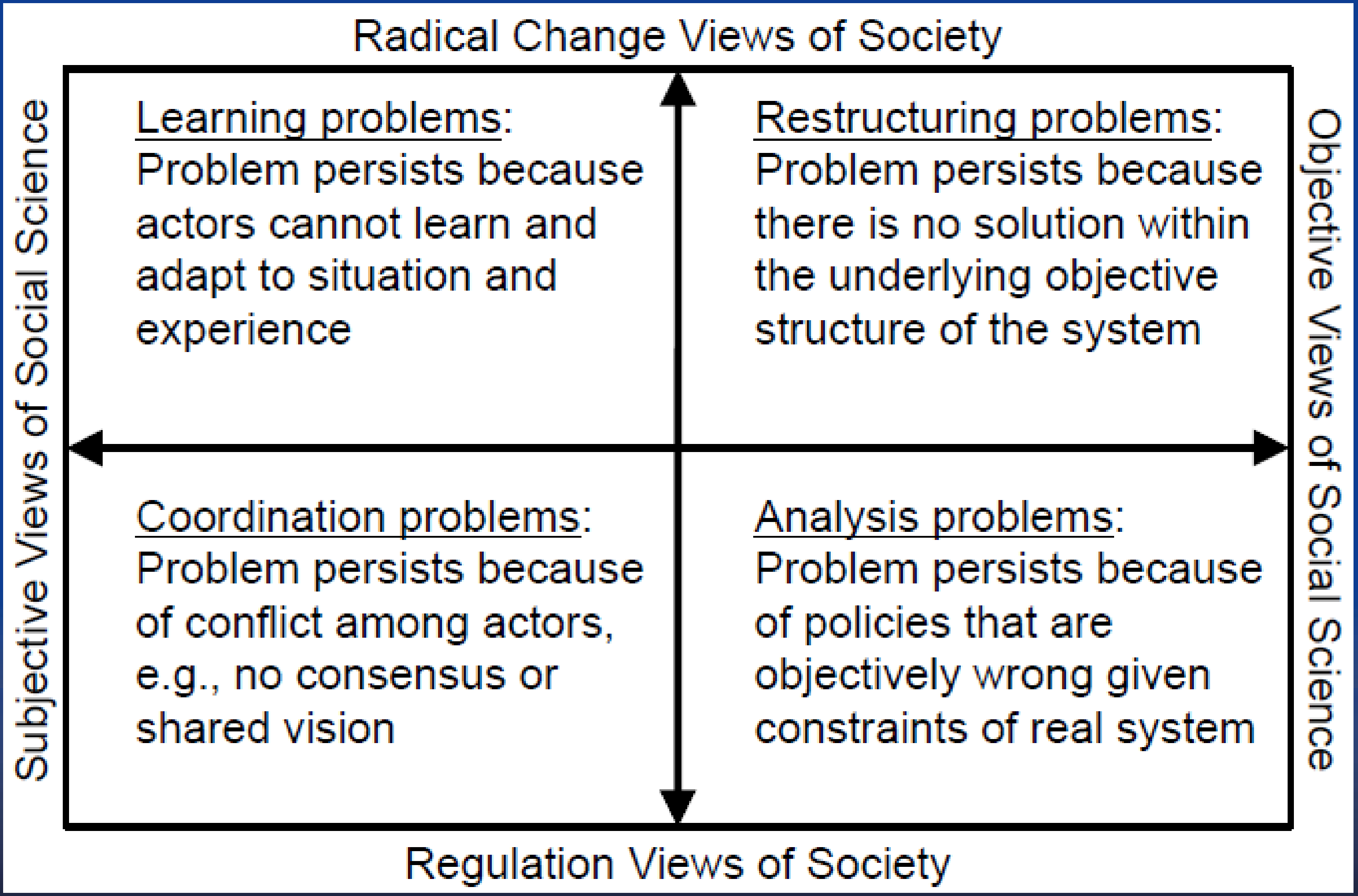


Lenton, T. M. (2011). Early warning of climate tipping points. *Nature Climate Change*. 1: 201-209.

Correctly Identifying the Problems that Need to be Solved

SHIFTING FRAMES

Problem Types



What Type is This?

- How much is it primarily a learning problem?
- Learning of what type?
  - Single loop
  - Double loop
  - Triple loop
- How much do we need downscaled climate information to address the concern?
- Where are the points of leverage and where are the potential co-benefits to adaptation and mitigation action?

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Summary

- Based on past experience, climate change is likely to disproportionately affect older adults
- We have considerable understanding of risk and specific exposure and vulnerability concerns
- We need additional information on morbidity
- Overall vulnerability is dynamic, however, and dynamic methods are needed to project future risks
- We need to ask the right questions, avoid opportunity costs, and focus on what works


Thank you!